

Determination of Domestic Kitchen Characteristics for Elderly Turkish Women: A Comprehensive Ergonomics Approach

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How to cite this paper: Özalp, B.T. (2020) Determination of Domestic Kitchen Characteristics for Elderly Turkish Women: A Comprehensive Ergonomics Approach. *Open Journal of Safety Science and Technology*, 10, 53-67.

<https://doi.org/10.4236/ojsst.2020.102005>

Received: May 19, 2020

Accepted: June 25, 2020

Published: June 28, 2020

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Abstract

Objective: The paper aimed to present a layout of the kitchen for elderly Turkish women to assure their safety and comfort while executing their tasks in their kitchen. **Background:** It is appropriate to regard the domestic kitchen used by an elderly woman as her workplace, requiring application of the ergonomics principles such as environmental conditions, equipment design and workplace layout on the kitchen floor. The purpose is to enable them to perform activities in the kitchen comfortably, safely and without assistance. Ergonomic design takes into account the abilities and limitations due to aging and helps to create the best person-environment fit. Proper design can help all people in all age groups but is particularly important for elderly individuals. Safety, physical and social health must be taken into consideration to increase the quality of elderly Turkish women's lives. **Method:** The general layout of the kitchen was designed considering the work triangle, to minimize the walking distance in regard of the work sequence. The required functional anthropometric data for elderly Turkish women were obtained by ratio scaling method using the raw data from previous work. **Results:** The design of cabinets, worktops, base units, storage areas and their lay-out with kitchen appliances were realized to ensure comfort and safety for the elderly Turkish women. A U-shaped kitchen is found appropriate allowing the elderly woman and her company working together. For the counter, the height of the worktop is found as 860 mm from the floor and a 20 mm thick and 620 mm wide granite block is chosen. Placement of wall cupboards is achieved by considering the vertical grip reach of elderly Turkish women (5%) and the height of each shelf from the floor is determined. **Conclusion:** The absence of housing standard definitions addressing accessibility of the elderly is an ongoing problem in Turkey. This work presents potential solutions to improve the living standards of the elderly Turkish women.

Keywords

Kitchen Design, Elderly Women, Workspace, Slips and Falls, Anthropometric Measurements, Turkey

1. Introduction

Due to improvements in health care, the proportion of senior citizens in the general population of Turkey will continue to increase. The “Turkish Statistical Institute” considers someone of 65 years and more an “elderly” person [1]. Civil servants are retired at the age of 65 in Turkey. In 2017, the population aged 65 years and over was 6.9 million people, which comprises 8.5% of the total population. That year, the elderly female population was 3.9 million, which constitutes 9.6% of the total female population [2]. By 2023, this population will increase to 4.9 million women, and the rate will increase to 11.3%. If this trend continues, the ratio is estimated to increase to 17.7% by 2040 [3]. Because of the rapid increase in the number of elderly women in Turkey, it is imperative to invest in and redesign the kitchen to reduce injuries among this group.

1.1. Characteristics of Elderly Women: Physical Changes

Aging is an inevitable process, and old age is known to be the most sensitive era of life. Aging is defined as “the process of progressive change in the biological, physiological and social structure of individuals” [4].

As women age, their sensory systems are affected, including hearing, taste, smell, touch, muscle function and balance [5]. Some sensory systems are more important in everyday functioning than others. As a person ages, they need brighter lights, louder sounds and stronger smells. Color blindness tends to increase, especially among men [6]. For older adults, lights need to be brighter and illumination should be increased by 20% [7]. Cataracts are the most common age-related disorder of the eye. Changes in a person’s hearing start at the age of forties and progress with age [5]. Inevitably, the human body and mind age and lose the capabilities that were still available in the middle years [8].

With age, nervous system activities are slowed. Older women are usually slower in receiving information through sensory receptors, slower in transmitting, processing and interpreting information and somewhat slower in acting upon it than younger women [5].

1.2. Unintentional Non-Fatal Home-Related Injuries among Elderly Turkish Women

Elderly women, if they have economic freedom, prefer to continue living in their houses instead of moving to a nursing home. Living in one’s home has major advantages because one is in a familiar setting with all its physical and emotional implications. Reduced auditory and visual perception associated with aging to-

gether with balance disorders, chronic diseases and loss of coordination can result in an increased risk of accidents [9] [10]; furthermore, falls are not only common in developed countries. Reports from developed countries have shown that up to one-third of community-dwelling older adults fall each year, and fall-related injuries and their social consequences have increased [11] [12]. Although problems related to falls have been well studied in developed countries, few studies have been conducted in developing countries [13] [14].

Halil *et al.* [15] investigated the occurrence of and factors correlated with falls among the elderly in Turkey. A total of 2322 patients aged ≥ 65 who presented to the outpatient clinic of the reference hospital were questioned for their fall history. 63.5% of the participants were female, and 28.5% of them had fallen within one year. 19.7% of the participants were living alone, while 52.1% were living with her/his partner; 19.1% lived with her/his relatives, and 9.1% were living in a nursing home. Female fall rate was higher than men (32.7% vs 21.3%). Sütölk *et al.* [16] reported home accidents, with a male to female ratio of 123 (42.1%) to 169 (57.9%) ($p < 0.05$). Falls (44.5%) were the major causes of injuries. Falls were significantly more frequent among those 65 years and older compared to younger adults ($p < 0.05$). While women tended to experience accidents inside the house, men tended to experience them outside the house ($p < 0.01$). Among all cases, 1.3% were due to domestic accidents, with a higher percentage in women than men.

Şahin and Erkal [17] evaluated the home accidents and fall behaviors of an elderly Turkish population, which included 175 elderly residents in the Ovacık district of the Kırıkkale province of Turkey, by using a questionnaire. The “Falls Behavioral Scale for the Elderly” was employed as the data collection tool. More than half of the elderly population (59.4%) sustained home accidents in the previous year, and elderly individuals who sustained accidental falls (70.2%) and those who experienced accidents in the kitchen (31.7%) ranked first. The mean score of the elderly fall behaviour was 2.85 points on a four-point scale. The fall behaviour of the elderly indicated significant differences in terms of the type and place of accidents ($p < 0.05$). When group averages were evaluated, the elderly individuals who sustained cuts or home accidents in the kitchen had higher scores on the scale than the other groups.

Determination of risk factors in the kitchens of elderly women may change legal flat regulations for house constructors, which may significantly reduce the number of injuries and disabilities related to household injuries. In fact, elderly people have greater difficulty adjusting to inappropriately high worktops than people under the age of 65. In kitchen design, the optimal heights and depths of worktops and storage places should also be considered in terms of accessibility and the load on the spinal cord.

1.3. Risk Factors Associated with Housing Conditions

The main risk factors for all types of home accidents include not only the characteristics of elderly women but also housing conditions. It may be impossible

to overcome individual factors, but accidents may be avoided by improving the housing conditions for elderly women; in other words, adopting living space to the needs of elderly women can reduce the risk of injury [9]. In addition to passage areas, such as stairs and hallways, kitchens and bathrooms are particularly important, as they are the places where most accidents occur. Falling on wet surfaces is a major accident that occurs to elderly people in their houses. However, these accidents can be prevented by using a rubber mat with suction cups on one side. The mat is placed on the bathtub or shower stall floor before bathing to prevent slipping. Falling on stairs occurs infrequently (<5% of all falls in the house) [18]. Exposed electrical wiring (extension cords, lamps or telephone cord) within the walking area may be the cause of accidents for elderly women and men.

Statistics reveal that most accidents occur to women aged 65 or more and usually occur in the kitchen and bathroom. Therefore, the aim of the ergonomist should be the redesign of the kitchen and the bathroom for elderly women living alone to enable them to execute their daily activities comfortably, safely and without assistance.

Elderly women spent most of their day cooking, eating and for social activities with friends in the kitchen. Thus, the kitchen should be adapted to the physical and psychological characteristics of elderly people [19]. Câmara *et al.* [20] suggested the following:

- 1) Good lighting and easy access to switches is necessary. For that, switches must be easy to use and located 1.10 to 1.30 metres from the floor.
- 2) Local lighting units, such as 400 mm long fluorescent tubes, can be placed just underneath the cupboard, hung on the kitchen wall just over the dishwasher, sink, oven and work space.
- 3) The oven, sink and fridge should be placed to form a working triangle.
- 4) A minimum space between workbenches should be available to move and work.
- 5) For placement of cupboards and appliances, one must pay attention to the layout to avoid disturbing the space to circulate and activities.
- 6) Kitchen can be designed to hold the laundry machine if necessary, but an additional fan over the drier may be needed to address the resulting condensation.

The basic principle of ergonomics or human factors is design to fit the characteristics of the user population. The common underlying assumption is that users are all healthy adults and that the user population is not heterogeneous but is composed of individuals whose characteristics and capabilities are all similar. A kitchen designed for elderly women must have ergonomic dimensions. Attention should be paid to the design of kitchen furniture that complies with the user's stature and posture. Basic dimensions such as size, shape, height, and horizontal or vertical spacing affect entire residential environments and influence the safety and comfort. Accessibility, clearance and reach must cover both horizontal and vertical distance for individual elderly users.

2. Methodology

2.1. Lillian and Frank Gilbreth's Kitchen Triangle

Frank Gilbreth and Lillian Gilbreth studied the kitchen plan in the 1920s, and Niebel and Freivalds reported their study in 1999 [21]. Their study placed special emphasis on the best flow of activities in the kitchen. The work sequences show that there are three activities that relate to three main appliances: the refrigerator, the sink and the cooker (range). The relationship of these three fittings is commonly referred to as the work triangle or the kitchen triangle. The optimum length of the kitchen triangle is expected to be between 3.6 and 6.6 m. If the length is less than 3.6 m, the worktop length is too short. If it is more than 6.6 m, walking will be time consuming and may tire an elderly Turkish woman. The total length of the three sides of this triangle measured from the centre of each appliance should not be less than 3.5 m or more than 6.5 m long. As a result, a small, relatively compact kitchen is easier to work in than a large kitchen.

Layouts of a simple kitchen could be in-line, L-shaped or U-shaped [22]. The U-shaped kitchen is often the easiest to use as the appliances surround the cook and are set in worktops unbroken by circulation (Table 1) (Figure 1). U-shaped kitchen is chosen for the elderly Turkish women's kitchen.

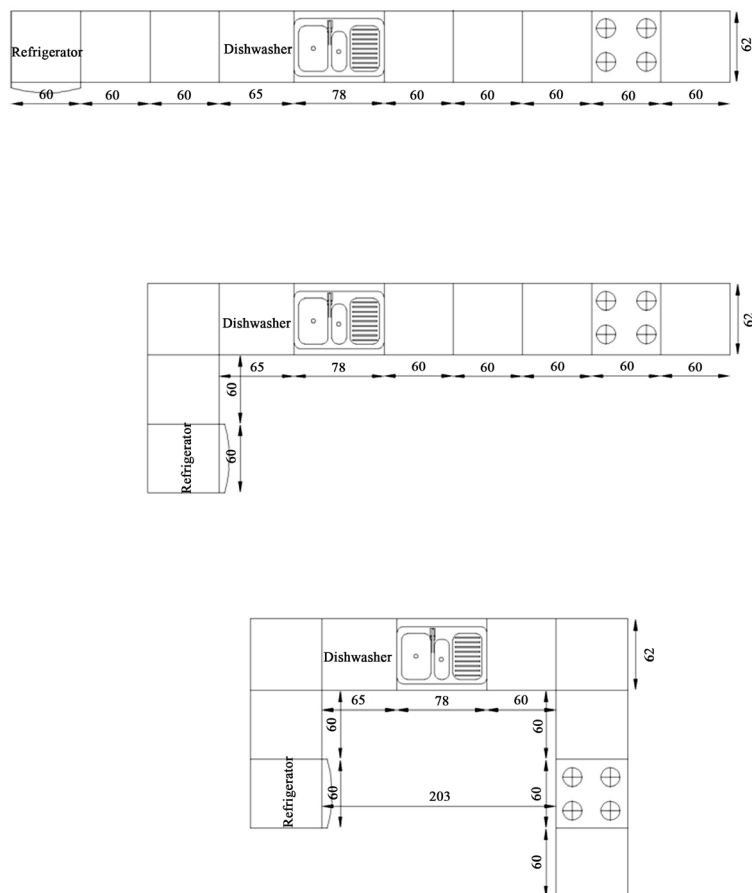


Figure 1. Three kitchen layouts. Each includes a range, refrigerator and a 160 mm deep sink (in cm).

Table 1. Kitchen triangle values for three different kitchen types (in cm).

	Line Type	L-shaped	U-shaped
Sink to Range	249	249	133.79
Sink to Fridge	254	137.54	137.54
Fridge to Range	503	364.29	203
Δ	1006	750.83	474.3

2.2. Estimated Anthropometric Measurements of Turkish Adults and Effect of Age

According to the standard anthropometric protocols, weight, height, skin fold thickness and arm circumference were determined, and the body mass index (BMI), fat free mass index and arm fat area were calculated for women living in Turkish nursing homes. However, complete body measurements that are necessary for the kitchen design have not been reported. İşeri and Arslan [23] estimated the anthropometric characteristics of the Turkish people. A survey of 4205 samples of 2263 males and 1942 female civilian subjects was conducted in 2007. It contained data from all seven geographical regions in Turkey and from all age groups. They used the “ratio scaling” technique to estimate the updated body measurements mostly used in the industry [24]. With this method, two coefficients were calculated (E1, E2) for each dimension, using data from the reference population. For this purpose, the researchers used Çiner’s [25] study of the anthropology of Turkish females as a reference for Turkish females. In this study, anthropometric data of Turkish women aged ≥ 65 ($n = 79$) were selected to estimate the updated relevant measurements using the raw population data from İşeri [26]. The list of the calculated body measurements of elderly Turkish women are given in **Table 2**.

2.3. Goals When Designing the Kitchen for Elderly Turkish Women

- Easy to reach the shelves over the counter,
- No bending or stretching movements when working in the kitchen,
- Simple maintenance and cleaning of the kitchen floor and utensils,
- Floor material is non-slip even when wet, and no-threshold entries into the kitchen are used,
- A notched profile at the bottom of the every base floor cabinet,
- Toe-knee space for close access to the sink and cabinet and control of doors, windows, cabinets, and appliances is effortless/consistent, secure and consistent with common sense,
- No-threshold entries into the kitchen.

3. Prospective Kitchen Characteristics and Discussion

Elderly women become easily tired when they work for a long time in a large kitchen. As a result, they may show decreased stability and may fall down and

Table 2. Body measurements of Turkish elderly women aged ≥ 65 , $n = 79$ (in mm).

	E1 (MEAN)	E2 (SD)	50th	SD	5th	95th
Stature	1.000	1.000	1554.34	92.54	1402.58	1706.10
Eye height	0.934	0.961	1451.76	88.93	1305.91	1597.60
Shoulder height	0.818	0.934	1271.45	86.43	1129.70	1413.20
Elbow height	0.628	0.724	976.13	67.00	866.25	1086.00
Hip height	0.510	0.684	792.71	63.30	688.91	896.52
Knuckle height	0.453	0.592	704.12	54.78	614.27	793.96
Fingertip height	0.393	0.618	610.86	57.19	517.07	704.65
Sitting height	0.531	0.539	825.36	49.88	743.56	907.16
Sitting eye height	0.461	0.513	716.55	47.47	638.70	794.41
Sitting shoulder height	0.349	0.474	542.47	43.86	470.53	614.40
Sitting elbow height	0.145	0.447	225.38	41.36	157.54	293.22
Thigh thickness	0.096	0.276	149.22	25.54	107.33	191.10
Buttock-knee length	0.356	0.474	553.35	43.86	481.41	625.28
Buttock-popliteal length	0.297	0.474	461.64	43.86	389.70	533.58
Knee height	0.309	0.434	480.29	40.16	414.43	546.16
Popliteal height	0.247	0.408	383.92	37.76	322.00	445.84
Shoulder breadth (bideltoïd)	0.229	0.316	355.94	29.24	307.99	403.90
Shoulder breadth (biacromial)	0.221	0.303	343.51	28.04	297.53	389.49
Hip breadth	0.193	0.500	299.99	46.27	224.11	375.87
Chest (bust) depth	0.162	0.355	251.80	32.85	197.93	305.68
Abdominal depth	0.164	0.513	254.91	47.47	177.06	332.77
Shoulder-elbow length	0.171	0.421	265.79	38.96	201.90	329.68
Elbow-fingertip length	0.267	0.316	415.01	29.24	367.05	462.97
Upper limb length	0.439	0.539	682.36	49.88	600.56	764.16
Shoulder-grip length	0.373	0.474	579.77	43.86	507.83	651.71
Head length	0.111	0.105	172.53	9.72	156.60	188.47
Head breadth	0.096	0.105	149.22	9.72	133.28	165.15
Hand length	0.105	0.132	163.21	12.22	143.17	183.24
Hand breadth	0.047	0.079	73.05	7.31	61.06	85.04
Foot length	0.145	0.184	225.38	17.03	197.46	253.30
Foot breadth	0.055	0.092	85.49	8.51	71.53	99.45
Span	0.997	1.145	1549.68	105.96	1375.91	1723.45
Elbow span	0.527	0.697	819.14	64.50	713.36	924.92
Vertical grip reach (standing)	1.177	1.158	1829.46	107.16	1653.72	2005.20
Vertical grip reach (sitting)	0.714	0.855	1109.80	79.12	980.04	1239.56
Forward grip reach	0.435	0.553	676.14	51.17	592.21	760.06

hurt themselves. For this reason, the type of the kitchen and its dimensions are chosen to be as short as possible. However, in addition to the short dimensions, sufficient worktop length must be provided for elderly Turkish women to work on it.

The range and the refrigerator are placed on the same line and in a face-to-face position. Because the range also has the furnace, the distance between the range and refrigerator has been assessed to determine whether a sufficient workplace is left; it is assumed that the elderly Turkish woman and her company are busy in front of the furnace of the range and the refrigerator door (**Figure 2**).

The Work Area in Front of the Refrigerator = Width of the Refrigerator Door = 600 mm; The Work Area in Front of the Furnace of the Range = The Height of the Furnace Door (in the opened position) + Buttock-Knee Length of the Elderly Turkish Woman (95%) + Turkish Women's Clothing Thickness = 450 + 625.28 + 19 = 1094.28 mm.

Total Working Area = 1094.28 + 600 = 1694.28 mm.

1694.28 mm is less than the distance between the range and the refrigerator which is calculated as 2030 mm in this work.

3.1. The Kitchen Counter

There has been much controversy about the ideal height of the kitchen counter-top, as it must be appropriate for elderly Turkish women whose height (50%) is 1554 mm. The recommended standard height of worktops differs according to the height of the user: the workspace is expected to be below the elbow height. This may help with manipulation and visual controls. Ward and Kirk [27] studied the height of the worktop by means of a fitting trial. All selected women performed three groups of tasks and selected the optimal worktop [22].

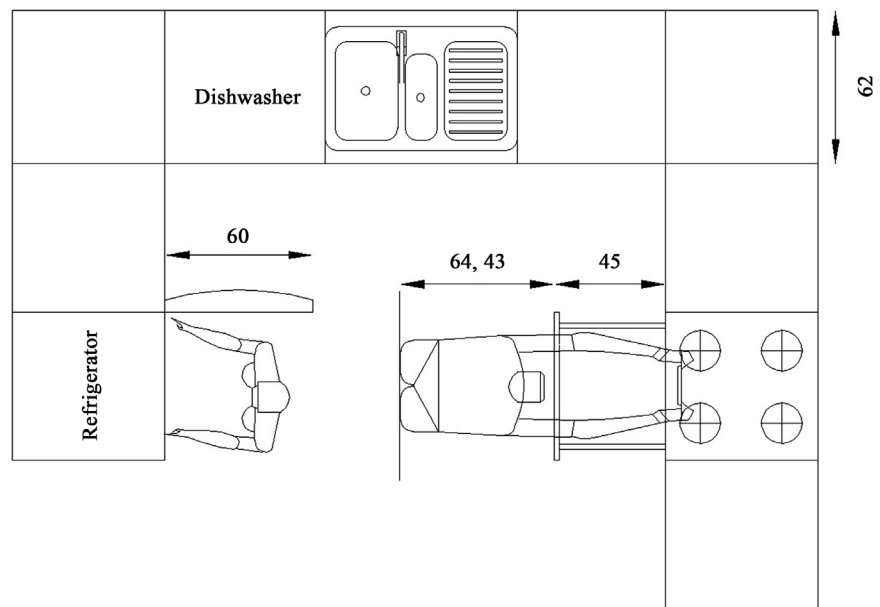


Figure 2. Working areas in a U-shaped kitchen (in cm).

Group A: Tasks performed above the worktop (peeling vegetables, mixing, and slicing bread); women thought that the height of the worktop would be 119 mm below the elbow height [28].

$$h = 976.13 - 119 = 857 \text{ mm}$$

Group B: Tasks performed on the surface (spreading butter on a slice of bread, chopping ingredients using the mixer, etc.). Height is 88 mm below elbow height.

$$h = 976.13 - 88 = 888.13 \text{ mm}$$

Group C: Tasks involving downward pressure, such as rolling pastry and ironing clothes; 122 mm below elbow height.

$$h = 976.13 - 122 = 854 \text{ mm}$$

However, because the height of the Turkish-made range is 850 mm and the Turkish-made dishwasher is 840 mm, the height of the worktop was chosen as 860 mm from the floor, especially for the range, as frying pans must be safely rested down on the counter after use. The work surface needs to be chosen to fit along the top of the base units—the choice is normally between laminated and stone (granite, slate, etc.) worktops. For the kitchen counter, a 20 mm thick and 620 mm wide granite block was chosen.

3.2. The Turkish-Made Range

Nearly all private homes, including both houses and flats, have a kitchen of some kind. Most apartments include a range, a single appliance that incorporates both a stove and an oven in a compact unit. Many elderly women take advantage of this easy solution by installing a range in the kitchen of their house to save space and to increase user convenience. Turkish-made ranges are usually powered by electricity, natural gas or LPG, and its dimensions are 600 × 600 × 840 mm.

3.3. Sink, Fridge and Dishwasher

Turkish-made appliances were chosen for the kitchen. Stainless steel sink is 500 mm wide and 780 mm long. It has only a 1.5 bowl, which is 160 mm deep. The refrigerator is in 600 × 600 × 1750 mm dimensions and the dishwasher with 600 × 600 × 840 mm size is placed on the right side of the sink under the worktop.

3.4. Wall Cupboards

Wall cupboards should not be fixed lower than 400 mm above the countertop; otherwise, they will obscure the back of the counter. In the kitchen, which is planned here for elderly Turkish women, wall cupboards are fixed to 450 mm above the kitchen worktop. Because the height of the worktop is 860 mm, 860 + 450 = 1310 mm is the distance between the floor and the first shelf of the wall cupboards. The vertical grip reach (standing position) of elderly Turkish women is calculated as 1653.72 mm for 5% of elderly Turkish women (age 65 years and over). The maximum height from the floor that elderly Turkish women can reach

has been calculated as 1653.72 mm + 40 mm (slipper height) = 1693.72 mm. With the shelf height as 150 mm (where one can place 12 porcelain dishes in a pile or a stainless steel sauce pan easily), the height of the shelves from the floor is given in **Table 3**.

The wall cupboard should not be too high for the elderly women’s kitchen. Wall cupboard doors should not be too wide, as 300 mm is the ideal maximum width to reduce the chance of banging one’s head on a door if left open. This design eliminates the possibility of the user hitting her head against the overhead cabinets when she is close to the worktop.

There are five wall units with two cupboard doors and two wall units with one cupboard door hanging on the wall over the worktop. General view of the kitchen designed can be seen in **Figure 3**.

- 1) There is one over the dishwasher with two doors; each door is 300 mm wide and 440 mm high.
- 2) The second one is over the sink and has two doors; each door is 360 mm wide and 440 mm high.
- 3) The third one is over the worktop, which is over the drawers, and has only two doors that are each 300 mm wide.
- 4) The two-door cabinets are placed on both sides of the range. Each of these doors is also 300 mm wide and 440 mm high.
- 5) There are one-door cabinets on the corner of the worktop, which is on the right side of the range. Each of the two cabinets on the corner is 360 mm wide and 440 mm high.

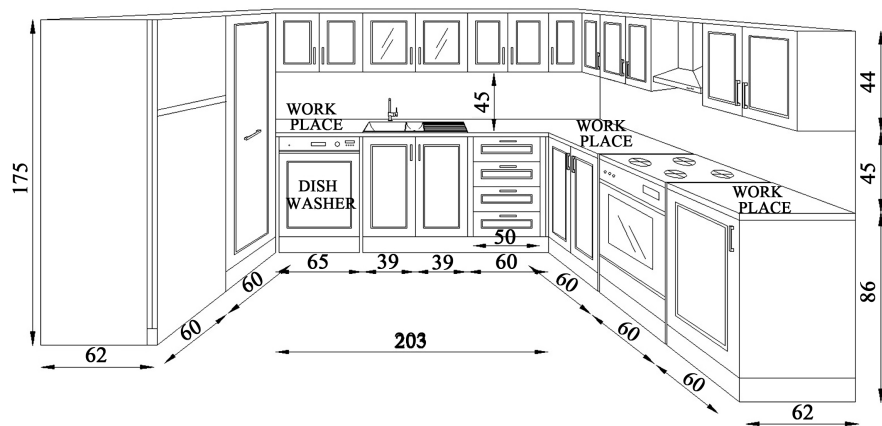


Figure 3. General view of the kitchen (in cm).

Table 3. Height of the wall cupboard shelves from the floor (in mm).

Shelves	Distance from the Floor	Distance between Shelves
I. Shelf	1310	
II. Shelf	1460	150
III. Shelf	1610	150
Top of the wall cupboards	1750	140

3.5. Floor Material

Turkish ceramic floor tiles with dimensions of 400×400 mm were chosen for the elderly Turkish women's kitchen. These are tiles whose surfaces are made with matte glaze for better slip resistance than glossy glazes. Their edges are rounded after the tile sizing. This process prevents damage to the user. At the same time, it prevents edge breaks.

3.6. Base Units

3.6.1. Cupboards under the Worktop

At the bottom of the every base floor cabinet, there must be a notched profile below the front door of the cabinet. This notched profile, called the toe kick, is an ergonomic feature that is designed to increase the safety and comfort of working on the countertop (worktop). Essentially, the toe kick allows a user to place her toes slightly under the cabinet while working on the countertop. This might seem like a small advantage, but a long process, such as preparing dough, which involves making a thin layer of dough with a rolling pin for a flaky pastry, shows that this small amount makes it much easier for a user to stand for long periods without uncomfortable leaning and without struggling to maintain balance. The optimal depth for a toe kick is 75 mm and 100 mm high from the floor. This provides an adequate recess to stand comfortably and maintain balance while working at the countertop. A continuous toe recess at the bottom of all cabinets is provided.

A sink base cabinet is a cabinet that has been designed to use with a sink. This style of a cabinet depends on the type of a sink that will be installed. Because the sink is placed in the middle of the U-shaped kitchen, the base cabinet under the sink is also placed in the middle of the U-shaped kitchen. Sink base cabinets do not have shelves that may interfere with water lines, waste traps and any other pipes that are under the sink. The cabinet has two doors, each with dimensions of 360 mm width and 650 mm height. Doors are fixed to the vertical columns, which are made from the same material used for the production of the cabinet doors. An 80 mm wide wooden band prepared from the same material used in manufacturing of the cabinet doors should be placed under the worktop. Thus, the door assembly of base cabinets can be carried out through the entire worktop. The width of the base cabinet under the sink is 400 mm.

The other cabinet with two doors is just under the worktop, which is on the right side of the range. The last cabinet has one door and is placed just under the worktop, which is on the left side of the range. The cabinet with two doors on the right side of the range has a shelf. This cabinet can generally be used to store the frying pans, a pressure cooker set and a set of saucepans.

3.6.2. Drawers under the Worktop

The height of the base unit is taken as 860 mm. However, the real cavity for drawers is $860 - 20$ mm (worktop thickness) = 840 mm.

Variations of the drawer line style include units with three or four drawers.

On three-drawer base units, the top two drawers are often the same height, while the bottom drawer is double height. On four-drawer base units, all the drawers have the same height. Four-drawer styles were chosen for the elderly Turkish women's kitchen. The drawer line unit that is constructed under the worktop is next to the left side of the base cabinet, which is just under the sink. The widths of the drawers are 500 mm each. In addition, the length of them is as follows: 620 mm (depth of the worktop); 25 mm from the front edge of the worktop; 25 mm from the end of the worktop is used for easy transfer of the drawer under the worktop; $620 - 50 = 570$ mm is the length of the drawer.

The 1st drawer, just under the worktop, is used to store the cutlery set for breakfast.

The 2nd drawer, just under the first shelf, is used to store the cutlery set for meals.

The 3rd drawer, under the second shelf, is used to store the cutlery used for the meal service.

The 4th drawer is at the bottom is used to provide storage for pots, pans, oven trays, etc.

3.6.3. Waste Bins

For the segregation of kitchen waste, two separate waste bins are considered. The waste should be separated into wet and dry. Wet wastes are biodegradable organic materials that should be composted, and dry wastes are plastic, glass, paper, etc. that should be recycled.

A Turkish-made tandem two-bin waste system is chosen to maximize the usage volume of the cabinets. This system is placed inside the cupboard under the worktop, which is on the left side of the range. The system consists of telescopic rails that are mounted on the base of the cupboard, thus ensuring ease of usage simply by pulling out and pushing in the bins. During the operation, the bin cover is opened and closed automatically. The blue-coloured waste bin in the rear is used for the dry waste, and its volume is limited by 8 litres. Because of the frequency of food preparation and the resulting amount of food waste, a larger wet waste bin (16 L) is placed on the front and is colored green.

3.7. Pantry Cabinets for Elderly Turkish Women

It is difficult to accommodate a walk-in pantry in a small flat. Pantries for small kitchens need to maximize available space. Classic pull-outs do essentially the same thing, although they are slightly smaller. They are cabinets that have been converted into a pantry with stackable pull-out drawers with dividers to separate food items.

Double-door cabinets are good for small kitchens because they contain shelving layers that stack on top of one another and have shallow shelves on the inside of the door. Recess or reach-in cabinet pantries are optimal in-between choices. Cabinet shelves can be adjusted to hold tall boxes and bottles as well as canned goods and food items (non-perishables), such as various cereals, pastas

and snacks, including flour, lentils, pulses, macaroni, potatoes, onions, and garlic. If possible, a vertical row of cabinets for the pantry must be built next to the refrigerator to work with the natural flow of the elderly women's cooking preparation routine.

A tall cupboard which is $600 \times 600 \times 1750$ mm in size has been chosen for the elderly Turkish women's kitchen as a pantry. It is placed between the refrigerator and the dishwasher. There are shelves both inside the cabinet and inside the cabinet door. Both sets of shelves are connected such that when the door of the cabinet is opened, the complete set of drawers comes out. This suits the needs of elderly women because they will be able to reach every point of the complete drawer-set.

The Turkish-made "Mega Cellar with Lid Connection" (MCLC) has been chosen for the kitchen for the storage of canned food items, dry goods in glass or plastic boxes, olive oil, corn oil and sunflower oil in tin or plastic jars or bottles, honey or jam in glass jars. The MCLC has four shelves (each shelf resembles a basket) and each is in $380 \times 510 \times 120$ mm dimensions. The first basket is placed at a height of 200 mm from the bottom of the pantry. The distance between the shelves is taken as 400 mm.

Items for lifting and handling are commonly packaged into containers, such as boxes, crates, glass or earthenware jars, and pots. Plastic containers are preferred because they are lighter than glass or earthenware jars and pots. Drury [29] has revived the design of these containers; for loads that are to be lifted from the ground, it is advantageous for the width to be less than 300 mm, allowing the object to pass between rather than in front of the knees [22]. Therefore, plastic jars are used for non-perishables and glass jars for honey, jams and sugars.

Shelves are also placed inside the door of the cabinet. Each shelf has $130 \times 510 \times 120$ mm dimensions. When an elderly woman opens the door of her pantry, the complete set of drawers will come out automatically. Shallow shelving on the inside of the cabinet door is a good storage option for canned goods, bottles and spices.

4. Conclusions

Kitchen accidents happen frequently in old age. The most common mechanisms of injuries are falls. In this work, in order to prevent falls, analysis and application of ergonomics in the kitchen design for elderly Turkish women are presented to enable them to perform their activities in the kitchen comfortably, safely and without assistance, taking into account their abilities and limitations that come as a result of aging.

In order to determine the ideal kitchen characteristics, current literature on ergonomics aspects of housing and living environment was investigated and functional anthropometric data of elderly Turkish women were calculated. The ideal shape of kitchen has been chosen, taking into account the minimum walk-

ing distances, comfort and safety parameters. The design, selection and placement of all the necessary kitchen equipment, materials and fittings were realized by considering the accessibility, reach and safety of the elderly women.

Further research should include the effect of good lighting considering both daylight and electric lighting. Higher illumination without glare for working surfaces and high contrast in printed labels must be provided to prevent visual clutter. Moreover the need of functional anthropometric measurements is essential for the ergonomic interior design. More detailed measurements especially for older adults are of critical importance.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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